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UNITED STATES PATENT APPLICATION

of

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for

DEVICE FOR ENHANCING REMOVAL OF LIQUID
FROM FABRIC

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

This invention relates to a device for increasing the efficiency of a carpet-cleaning machine and other extraction machines in removing cleaning solution and other liquids from fabric, especially a carpet.

DESCRIPTION OF THE RELATED ART

Carpet-cleaning machines spray a cleaning solution onto a fabric carpet and then vacuum the solution from the carpet into the machine. Other extraction machines may spray a liquid onto a fabric or simply remove a pre-existing liquid from the fabric.

The inventor was unable to locate any prior art patent which dealt with increasing the volume of liquid which a carpet-cleaning or other extraction machine can remove from carpet or another fabric.

The closest invention appears to be the cleaning tool of United States Patent No. 4,270,238. According to lines 33 through 44 of column 2 in that patent:

"Two continuous rows of channel bristles are mounted on the one surface of the block assembly adjacent to its front and rear edges so that the distal ends of the bristles project outwardly from the one surface of the block assembly and contact the wall or ceiling to be cleaned during the cleaning operation.

"A plurality of nozzles are mounted on the one surface of the block assembly between the front and rear edges of the seembly and the adjacent rows of bristles and are used to uniformly wet all of the bristles in the rows of bristles with a cleaning fluid . . . ."

Line 62 of column 2 through line 14 of column 3 further provide:

"A pair of longitudinal slots are disposed in the one surface of the block assembly and are positioned equidistant about the central, transvers axis or centerline of the block assembly and midway between the continuous rows of bristles. The inner tapered ends of the slots communicate, via the interior of the wand, with a source of vacuum which causes air to be drawn into the slots during the cleaning operation. The shape of the slots is designed so that a relatively

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high velocity flow of air, as compared with the velocity of the air flow in the remainder of the tool, will be drawn generally uniformly into and through the slots. This air flow causes the cleaning fluid, together with the dirt suspended therein, to be stripped from the surface of the wall or ceiling almost immediately after the cleaning fluid has been applied. The substantially instantaneous extraction or removal of the cleaning fluid prevents the evaporation or drying of the cleaning fluid on the surface and also eliminates the cause of unsightly streaking by preventing cleaning fluid from trickling or running down and across a dry portion of the wall. . . ."

And lines 51 through 60 in column 6 elaborate:

". . . The design of the grooves **88** and **90**, the apertures **92** and **94** and the slots **96** and **98** assures that when the vacuum source **22** is being operated, air will be drawn into and through the slots **96** and **98** and into the apertures **92** and **94** at a relatively high velocity, as compared with the velocity of the air flowing downstream of the slots. As seen in FIG. 3, the highest velocity air flow is achieved as the air passes through the apertures **92** and **94** because these apertures provide the greatest restriction to air flow in the tool **10**."

Additionally, lines 25 through 28 of column 3 indicate:

"A spray nozzle may be mounted on the block assembly for spraying cleaning fluid directly onto the wall or ceiling to be cleaned prior to the use of our improved cleaning tool . . . ."

But, although United States Patent No. 4,270,238 recognizes that increased air velocity can be achieved by restricting flow and that this can assist in cleaning, nothing in the device of that patent forcibly directs the cleaning fluid to the apertures, the bristles would preclude a deep penetration into fabric or carpet by the tool even if the tool were intended to be used on fabric or carpet, there is no recognition of maximizing the total power of extraction for the machine, and no consideration is given to reducing boundary layer drag in the slots and apertures.

Similarly, in its concept for the suction nozzle for a vacuum, United States Patent No. 2,219,802 recognizes, on lines 39 through 42 of column 2, "Inasmuch as opening **27** is smaller than opening **16**, a more concentrated flow of air is obtained, which is able to remove the thread." But the nozzle is designed neither to forcibly direct a fluid into the an opening or to permit deeper penetration into carpet. Moreover, again there is no recognition of maximizing the

total power of extraction for the machine, and no consideration is given to reducing boundary layer drag in the nozzle.

And even though the vacuum tool of United States Patent No. 1,601,774 has apertures, they are so numerous as essentially to avoid restricting the flow of air in order to increase air speed, there is no recognition of maximizing the total power of extraction for the machine, and no consideration is given to reducing boundary layer drag in the apertures. In fact, the immense number of apertures most likely increases boundary layer drag. Furthermore, because the element containing the apertures rolls, it would not forcibly direct a fluid into the apertures. Nor is there any indication in the patent that the design of the roller facilitates deeper penetration into carpet. In fact, it would appear that penetration into the carpet is not desired because the patent, in line 5 through line 9 of column 1, asserts, "It is one of the principal objects of my invention to provide a vacuum tool which will roll easily and smoothly over a carpet, rugh or the like without pulling up its threads or nap."

The suction-cleaning implement of United States Patent No. 3,708,824 has tubular projections which are intended to reach the bottom of a carpet while cleaning of the upper level of the carpet is to be achieved through apertures in the base from which the tubes extend downward. A slidable plate selects either the tubes or the apertures in the base through which to draw air. Nothing, however, suggests that the tubes, the apertures in the base, or apertures in the slidable plate restrict air flow and thereby increase velocity, there is no recognition of maximizing the total power of extraction for the machine, and no consideration is given to reducing boundary layer drag. Moreover, there is no indication that the tubes increase pressure that can be exerted by the implement in order to achieve deeper penetration. It appears that such penetration is accomplished solely through the vertical extension provided by the tubes because the only reference (lines 34 through 35 of column 4) to the means of penetration by the tubes (which are called "teeth") indicates that they "provide combing action . . . ."

And the apertures of plate **15** in United States Patent No. 1,016,435 merely equalize pressure (*See*, *e.g.*, lines 44 through 51 in the left column on page 4). The grill **104** for the suction device in United States Patent No. 4,391,017 is, according to lines 35 through 27 of column 4, ". . . to prevent the device from becoming clogged by solid debris and thus reducing

its effectiveness." And the circular or oval chambers in the adapter plate for the nozzle of United States Patent No. 4,677,705 create rotary air currents to facilitate the removal of dust particles from carpets. There is no indication that the inventions of any of these patents restricts air flow to affect speed, there is no recognition of maximizing the total power of extraction for the machine, no consideration is given to reducing boundary layer drag. Additionally, nothing suggests this invention could forcibly direct a liquid into a nozzle or aperture or aid a nozzle to penetrate into a carpet. In fact, lines 27 through 30 and 32 through 33 of column 2 in United States Patent No. 4,677,705 state, "The exterior surface of the adapter plate is smooth and slides easily over each surface to be cleaned, irrespectively of how rough the latter is. . . . The adapter plate is not pulled by suction into the pile of a carpet . . . ."

SUMMARY OF THE INVENTION

The present invention is a device for attachment to the bottom of a wand or other nozzle that is used to vacuum liquid, especially liquid cleaning solution, from fabric, such as a carpet.

Two mechanical concepts and two aerodynamic techniques have been employed to enhance the extraction of the liquid from the fabric.

First concerning the mechanical concepts, barriers are attached to the portion of the Enhancement Device that will contact the fabric so that such barriers, when force is applied to the Enhancement Device will extend farther into the fabric than any other portion of the Enhancement Device. These barriers can be oriented and shaped in any fashion that will push any liquid in the fabric toward extraction nozzles as the Enhancement Device is moved across the fabric, in a manner similar to the way that a snow plow pushes snow ahead and to the side of the plow.

Second concerning the mechanical concepts, since pressure is equal to force divided by the component of surface area that applies such force and that is perpendicular to the body to which force is applied, the pressure exerted by the Enhancement Device upon fabric is increased by decreasing the surface area of the enhancement Device that contacts the fabric.

The extraction nozzles are apertures in the only portion of the Enhancement Device, other than the barriers, that will, when the Enhancement Device is used, face and contact the fabric and are generally located between the barriers. The existence of such apertures, therefore, decreases the surface area of the Enhancement Device that will contact the fabric.

The fact that, when force is applied to the Enhancement Device, the barriers extend farther into the fabric than any other portion of the Enhancement Device is also employed to further increase the pressure that the Enhancement Device exerts, for a given force, against the fabric since such barriers are constructed to have only a small surface area which contacts the fabric generally perpendicularly to the original orientation of such fabric.

Thus, the existence of the apertures and the construction of the barriers combine to increase the pressure that is exerted against a fabric when a given force is applied to the Extraction Device and, therefore, to increase the penetration of the Extraction Device into the fabric. Such increased penetration enhances the removal of any liquid in the fabric.

The first aerodynamic technique is adjusting the total cross-sectional area of the extraction nozzles to increase, and preferably maximize, the mass of air that moves through the extraction nozzles per unit time. The total power of extraction produced by a vacuum motor varies with air speed and is maximized at the point where the curves plotted (versus air speed) for pressure, which decreases with increasing air speed, and for volume of air, which increases with increasing air speed, cross. Since, in accordance with the Bernoulli principle, air speed varies inversely with the cross-sectional area through which a fluid can flow, the maximum extraction power for a given vacuum motor can be achieved by selecting the appropriate total cross-sectional area of the extraction nozzles; and, logically, such extraction power increases the closer such total cross-sectional area approaches to the appropriate quantity.

The second aerodynamic technique is reducing, and preferably minimizing, the boundary layer drag in the extraction nozzles. This is accomplished by reducing, and preferably minimizing, the ratio of the total distance along the perimeters of the extraction nozzles to the total cross-sectional area of the extraction nozzles, which, consequentially, minimizes the surface of the extraction nozzles to which the stream of air is exposed.

Finally, the cross-sectional area of each of the extraction nozzles is selected to be large enough to permit solid contaminants that can be expected to be in the liquid to pass through the extraction nozzles without clogging such nozzles.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows the bottom of the base plate for the Enhancement Device.

Figure 2 depicts a preferred shape for the base plate and a barrier as viewed from either end.

Figure 3 illustrates the preferred shape for the base plate and barrier as seen either from in front or behind.

Figure 4 portrays an optional embodiment having the barrier behind the aperture.

Figure 5 combines the embodiments of Figure 1 and Figure 4 so that barriers are located both generally between the apertures and behind the apertures.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The Device for Enhancing Removal of Liquid from Fabric can be constructed initially in a carpet-cleaning machine or other machine for extracting liquid from a fabric; alternatively, it can be attached to existing such machines.

The primary structure of the Enhancement Device is a base plate **1** having one or more apertures **2** which serve as extraction nozzles to remove liquid from a fabric when the Enhancement device has been built into or retrofitted on a vacuum machine, such as a carpet-cleaning machine.

Barriers **3** are attached to the bottom **4** of the base plate **1**, which is the portion of the base plate **1** that will face and contact the fabric, and are preferably an integral part of the base plate **1**. As discussed above, these barriers **3** can be oriented and shaped in any fashion that will force any liquid in the fabric toward the apertures **2** as the base plate **1** is moved across the fabric. For a machine that will generally be moved straight forward and straight reverse across a carpet, the barriers **3**, as viewed from below, preferably have a straight, elongated shape, as illustrated in Figure 1.

The barriers **3** are preferably generally located between apertures **2**, preferably between adjacent apertures **2**, as depicted in Figure 1.

The liquid tends to go laterally rather than further into the fabric for two reasons: (1) the fabric is denser under the barriers **3** because the barriers **3** are, in use, pressed against the fabric and (2) a vacuum is applied through the apertures **2**.

The construction of the barriers **3** is such that each barrier **3** has only a small surface area that will contact the fabric generally perpendicularly to the original orientation of such fabric. A preferred shape for a barrier **3**, as viewed from either end of the barrier **3**, to be used with a machine that will generally be moved straight forward and straight reverse across a fabric is a V shape which is preferably integrally formed in the base plate **1**, which is also preferably V shaped when viewed from either end, as shown in Figure 2. The view of this preferred shape for the barrier **3** and the base plate **1** from either in front of the base plate **1** or behind the base plate **1** is given in Figure 3.

Optionally, the barriers **3** can be located behind the apertures **2**, as portrayed in Figure 4. In such a case, a single barrier **3** preferably runs behind all the apertures **2**. Having a barrier **3** located behind the apertures **2**, with respect to the intended direction of movement for the base plate **1**, tends further to increase the probability that liquid will be drawn into the apertures **2** because an aperture **2** will not simply pass over the liquid; by the barrier **3** forcing the liquid to move with the aperture **2** as part of the process of forcing the liquid toward such aperture **2** the liquid will be retained for a longer period of time under the aperture **2** to which a vacuum is being applied.

A further optional embodiment, which is illustrated in Figure 5, has barriers **3** both generally between the apertures **2** and also behind the apertures **2**.

As discussed above, the existence of the apertures **2**; the fact that, when force is applied to the Enhancement Device, the barriers **3** extend farther into the fabric than any other portion of the Enhancement Device; and the construction of such barriers **3** to have only a small surface area which contacts the fabric generally perpendicularly to the original orientation of such fabric combine to decrease the surface areas of the Enhancement Device that will exert pressure on the fabric, *i.e.*, the barriers **3** and the base plate **1**, and thereby to increase the pressure and, consequently, the penetration of the barriers **3** and the base plate **1** achieved when a given force is applied to the Extraction Device. Such increased penetration of the base plate **1** enhances the removal of any liquid in the fabric.

The total cross-sectional area of the apertures **2** is selected to be that which, as explained above, increases, and preferably maximizes, the mass of air that moves through such apertures **2**; this is accomplished by selecting the total of the aperture size for all apertures **2** combined to create the speed of air through the apertures **2** that will increase, and preferably maximize, the extraction power for the vacuum with which the Enhancement Device is to be utilized. Additionally, the number and shape of the apertures **2** is selected to reduce boundary layer drag by reducing, and preferably minimizing, the ratio of the total distance along the perimeters of the apertures **2** to the total cross sectional area of such apertures **2**. This, as also explained above, minimizes the surface of the apertures **2** to which the stream of air is exposed.

Finally, again as discussed above, the cross-sectional area of the apertures **2** is selected to be large enough to permit solid contaminants that can be expected to be in the liquid to pass through the apertures **2** without clogging these apertures **2**. This is consistent with the other aerodynamic goals because, *e.g.*, the ratio of the total distance along the perimeters of the apertures **2** to the total cross-sectional area of such apertures **2**, when the apertures **2** are circles, is inversely proportional to the radius of such circles.